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APOLLO MONTHLY PROGRESS REPORT (u)

NAS9-150

150

June 1, 1964

Paragraph 8.1, Exhibit I

Report Period

April 16 to May 15, 1964

[redacted]

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ILLUSTRATIONS

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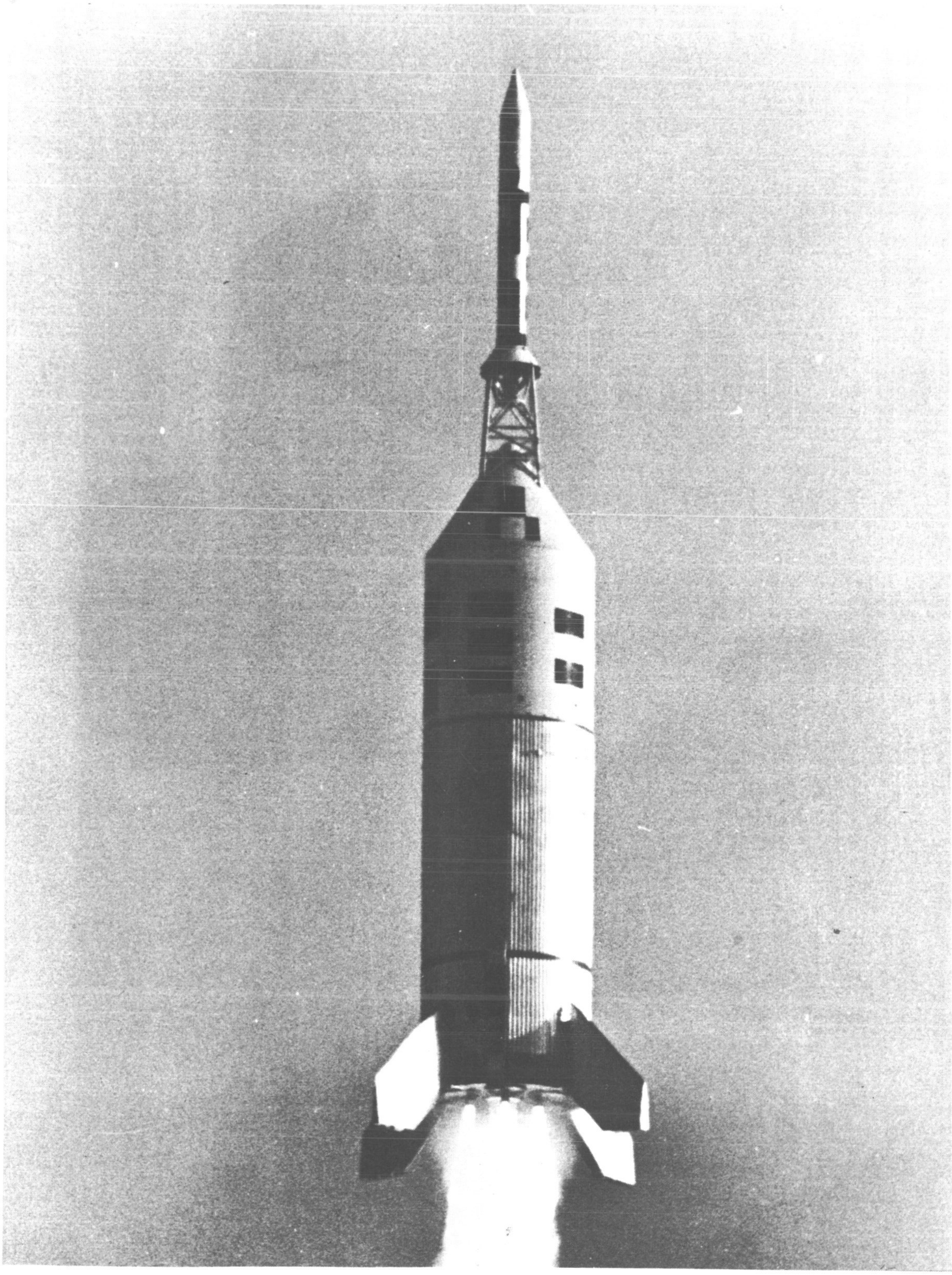

Figure 1. Boilerplate 12 Launch, White Sands Missile Range

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PROGRAM MANAGEMENT

STATUS SUMMARY

Boilerplate 12 was launched on a transonic abort test flight on May 13 (see Figure 1). Lift-off was at 6 a.m. MST. The flight was successful despite the severity of thrust termination of the Little Joe II booster and the loss of one main parachute at parachute ejection. First-look information appears in the Operations section of this report; detailed evaluation will be provided in the next report.

Six parachute drop tests were conducted at the El Centro Naval Air Facility during the report period. The tests were to evaluate the effect of removing part of the fifth ring and midgore reefing. The parachute bomb-drop test vehicles used a two-chute cluster. Blanketing conditions varied, but descent in all drops was normal to impact.

The mission for boilerplate 23 was changed, and the beginning of work on the change became effective during the report period. Boilerplate 23 is no longer a backup for boilerplate 12. It will serve as a transonic abort test vehicle in a mission above 20,000 feet to test the canard, boost cover, and dual drogue. The Los Angeles Division of NAA will build structural portions of the canard and the boost cover for the command module.

The service module for boilerplate 22 was shipped to MSC-Houston during the report period to undergo vibration testing. The module is scheduled for return to S&ID in July.

A major milestone was achieved when the service propulsion subsystem engine recently accomplished a continuous firing of 635 seconds at altitude. This firing demonstrated compliance with the maximum-duration firing required by specifications. It also demonstrated that the test cell is now capable of sustaining long-duration firings at simulated altitude. This test series concluded the Phase I test program at the Arnold Engineering Development Center.

An inspection and critique of the final configuration of the Block I manned spacecraft was conducted during the mock-up review of the command and service modules for spacecraft 011. A review was conducted in the mock-up area by NASA astronauts, who also performed task analysis walk-through (under vented suit conditions) for the prelaunch and reentry phases of the spacecraft mission.

DEVELOPMENT

AERODYNAMICS

The launch escape subsystem (LES) sequencing was completed for a high-altitude abort at or above 100,000 feet. The sequence of events and their times after abort initiation are as follows:

Canard deployment	11.0 seconds
Launch escape subsystem jettison	14.0 seconds
Drogue parachute mortar initiation	16.0 seconds

Pressure distributions on the canards in the closed position were established to determine latching loads. Aerodynamic design loads were also calculated for the canards during deployment. Figure 2 shows a mock-up of the canards in the deployed configuration.

The venting arrangement for the spacecraft lunar excursion module adapter was established. Vent holes totaling 200 square inches will be located on the S-IVB forward skirt, 122 inches aft of the skirt-instrumentation unit interface.

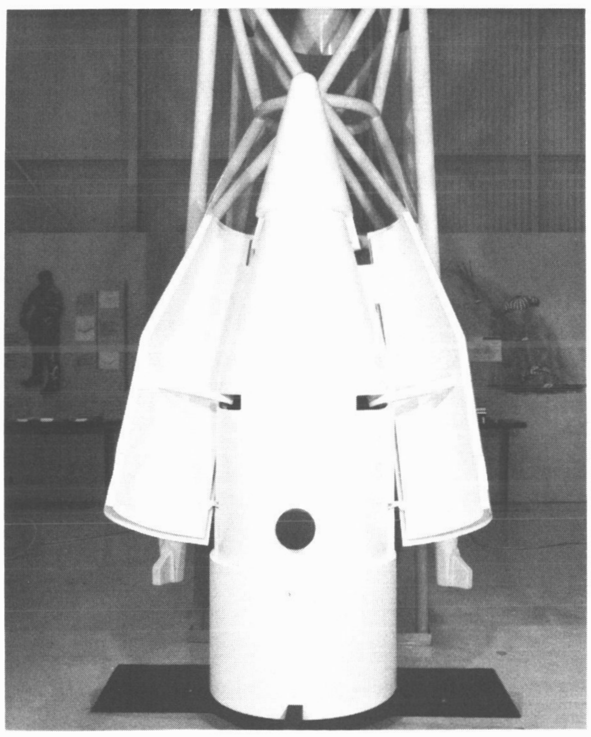

Figure 2. Mock-up of Canards in the Deployed Configuration

MISSION DESIGN

Two separate director and response testers (DART) will be provided, one for use with Saturn IB launch vehicles and a second for use with the Saturn V. The DART design requirements for the Saturn IB flights are in process. Those for Saturn V cannot be established until mission objectives have been defined.

The design missions concept was employed in the absence of planned missions for establishing DART design requirements. The design missions studied to date are compatible with the "Spacecraft Capability Requirements" as revised by NASA.

Velocity change (ΔV) requirements were established for aborts from nonfree return from translunar trajectories subsequent to perilune arrival. The nominal mission profile assumed a combined plane change and circularization maneuver at perilune to establish an 80-nautical-mile lunar equatorial parking orbit. Additional ground rules and conditions assumed were as follows:

1. Launch azimuth = 72 degrees
2. Launch in May 1969
3. Mean earth-moon distance
4. Combinations of north and south injections and north and south returns
5. Various combinations of translunar and transearth transit times of 60, 84, and 108 hours.
6. Return earth equatorial inclination = 34 degrees

ΔV versus time following perilune passage was plotted for each of the various transit time combinations and for north and south returns. The general trend of these curves was a decrease in ΔV for an increase in time to abort following perilune passage. These curves showed a tendency to level out to a constant ΔV between three and six hours following perilune passage. The results, summarized in Table 1, are based on the assumption that abort is initiated six hours after perilune passage.

Table 1. ΔV Required for Abort Six Hours After Perilune Passage*

Translunar Transit Time (hr)	Injection North	Return North South	ΔV Required for Abort (fps) for Transearth Transit Time of:				
			60 Hours	84 Hours	108 Hours	60—84 Hours	84—108 Hours
60	N	S	2100	1300	1900	2100	1900
	N	N	2200	1480	2030	2200	2030
84	N	S	1980	2700	3630	2700	3630
	N	N	2170	2800	3650	2800	3650
108	N	S	3470	3900	4580	3900	4580
	N	N	3610	4070	4730	4070	4730

*On any day of the month

CREW SYSTEMS

The first of a series of tests to simulate spacecraft mission phase coast and maneuvers was completed with approximately 754 training runs and 1246 data runs. This was a three-degrees-of-freedom study with a man in the loop to evaluate spacecraft propellant consumption and to evaluate the ability of three astronaut subjects to perform certain attitude change maneuvers under varying changes in rates and attitude angles. The subjects were tested both in a shirt-sleeve environment and wearing vented and pressurized International Latex Corporation state-of-the-art pressure suits. Attitude change maneuvers were performed for navigational sightings during lunar flight, lunar orbit, and Earth flight mission phases. The subjects experienced difficulty in making large, multi-axis attitude corrections because of the force they must apply on the rotational hand control and the length of time this force must be sustained. The pressurized suit restricted rotation control motion and caused difficulty in obtaining full throw of the control. Preliminary results of the simulation were made in an interim report; a final report is scheduled for release in mid-July.

Minimum dimensions were determined for Block II vehicles to satisfy crew ingress-egress requirements for the side hatch and the crew transfer tunnel. A 32-degree width for the side hatch and a 29.5-inch diameter crew transfer tunnel (27.56-inch minimum diameter at the ablative hatch mounting ring) are recommended. These minimum requirements are based upon evaluations of the tests conducted in a 1-g environment with the test subjects wearing state-of-the-art pressure garments. Any change in these parameters, such as a later development in the spacesuit, variations in the dimensions of the portable life support subsystem, changes in thermal (or other protective) overgarments, or changes in the docking mechanisms, would require a reexamination of these minimum requirements.

A detailed study reveals two feasible methods to repressurize the command module after crew transfer. The more rapid method of repressurization would partially deplete the oxygen surge tank but would permit the cabin pressure to reach 5±0.2 psia in 26.6 minutes. The other method is slower but is recommended as the nominal repressurization mode. This second method does not require the partial depletion of the oxygen surge tank and permits cabin pressure to reach 5±0.2 psia in 49.2 minutes.

STRUCTURAL DYNAMICS

Several methods of achieving flotation stability in the upright position only were analyzed for the Block I and proposed Block II spacecraft. The three most promising methods are the following:

1. Auxiliary flotation bags

2. Flooding of specially prepared areas in the aft portions of the command module

3. Repositioning of the crew couches after landing to change the center of gravity

Further analyses and tests using tenth-scale models are planned for Block II spacecraft after the configuration is determined.

The configuration of spacecraft 007 for modal and acoustic tests will be as follows: The command module will have a fiberglass heat shield and metal simulated windows. The service module fuel and oxidizer tanks will be empty during the acoustic test. Separate support fixtures will be used to hold the command and service modules during the test.

Over-all design concepts were established for the vibration test fixture to be used in determining shell and panel modes of spacecraft 007, and drawings were completed. Fabrication of the fixture is scheduled for completion in early June.

STRUCTURES

A study is being conducted to investigate a Block II service module configuration that provides a meteoroid bumper. The ground rules recently established by NASA will be used, and the configuration will be based on an over-all mission reliability goal of 0.999 in regard to possible failure caused by meteoroids. The Defense Research Laboratory of General Motors Corporation was awarded a contract to perform simulated meteoroid impact tests in support of this investigation.

Water landing impact analyses revealed that certain command module components and bracketry may present a puncture hazard to the inner aft bulkhead. Doublers attached by bonding were approved as a protective measure against possible punctures in those identified areas.

Design of the canard thruster was completed in support of schedules for boilerplate 23. The thruster is a pyrotechnic device having hydraulic damping action and a 7.5-inch stroke. Dual cartridges provide initial opening thruster pressures of 36,000 to 48,000 psi. This pressure range is achieved with either dual or single initiation. Damping forces can be varied by changing the orifices as required. Component testing will begin in June.

FLIGHT CONTROL SUBSYSTEM

A study of the displays subsystem, based upon the concept of no in-flight maintenance, was completed. The reconfigured subsystem would employ switchable hardwired redundancy.

Adapter sleeves are being used on subminiature connectors as an interim measure to prevent fractures resulting from crimping. A new contact annealed in the crimping area will provide a permanent solution of the problem.

A study of high-altitude LES aborts indicates that 101 to 215 seconds of time would be available for manual orientation of the command module. The available time is the interval between the rate stabilization of the command module subsequent to tower jettison and the time during entry at which the reaction control subsystem (RCS) dynamic authority is exceeded by aerodynamic moments. The study was based on nominal abort trajectories, dual RCS operation, and abort occurring at 120,000 feet altitude.

An investigation was made to determine permissible attitude deviations at the 0.05-g switching point for entry subsequent to a high-altitude LES abort. Assuming an abort altitude range from 120,000 to 320,000 feet and dual and single RCS operation, the permissible attitude deviation is +120 to +220 degrees for angle of attack and -50 to +50 degrees for angle of sideslip.

The conceptual design of DART for Saturn IB was mutually agreed upon by NASA, S&ID, MIT, and Bellcomm. A relatively simple sequencer with a capability for limited ground updating will be used.

TELECOMMUNICATIONS

A VHF cavity antenna was designed as a backup for the primary recovery antenna for manned spacecraft. This backup antenna is intended to be manually deployed in the event that the primary recovery antenna is inoperable for any reason. Spacecraft 009, being an unmanned vehicle, will employ a shallow-cavity VHF antenna installed between the inner and outer windows of the crew access hatch and connected to the VHF recovery beacon. Figure 3 shows a cross sectional view of the antenna mounted in place.

Procurement was initiated for a magnetic tape recorder with 14 tracks for recording direct, narrowband, and wideband frequency modulation (FM), or pulse duration modulation (PDM). This secondary on-board recorder is needed for storage of flight qualification data on early spacecraft flights. No provision is being made for recording or playback of pulse code modulation (PCM) data, because these data will be recorded on the primary on-board data storage equipment. During normal operation, 2 of the 14 tracks will be used for reference and time code recording. 30 minutes of recording time are provided at a tape speed of 15 inches per second. An alternate speed of 120 inches per second is provided for fast forward or rewind. End-of-tape sensing with automatic tape transport shutoff is provided in both directions.

ENVIRONMENT CONTROL

The environmental control subsystem (ECS) interim breadboard tests were completed. The final test was at a simulated altitude of 200,000 feet for 4.5 hours. As part of the final test, water boiloff was used as a temperature control. Using this control, the outlet temperature from the glycol evaporator was held between 39 F and 43 F with an inlet temperature of approximately 80 F.

A thermal analysis was completed for the environment encountered by the inertial measurement unit (IMU) during transport of the spacecraft from the assembly building to the launch pad at the Kennedy Spacecraft Center (KSC). The analysis shows that the maximum allowable temperature of 130 F will not be exceeded. The study further indicates that 90 hours of uncontrolled exposure to the minimum anticipated environmental conditions are required before the temperature will drop below the allowable minimum temperature of 30 F.

Structural temperature differences across the canards were calculated for a Saturn V boost and subsequent abort at 120,000 feet altitude. These data are in support of thermal stress calculations. The studies showed that, for tumbling entry trajectory, the maximum difference is 200 F; for a non-tumbling trajectory, the maximum difference is 370 F.

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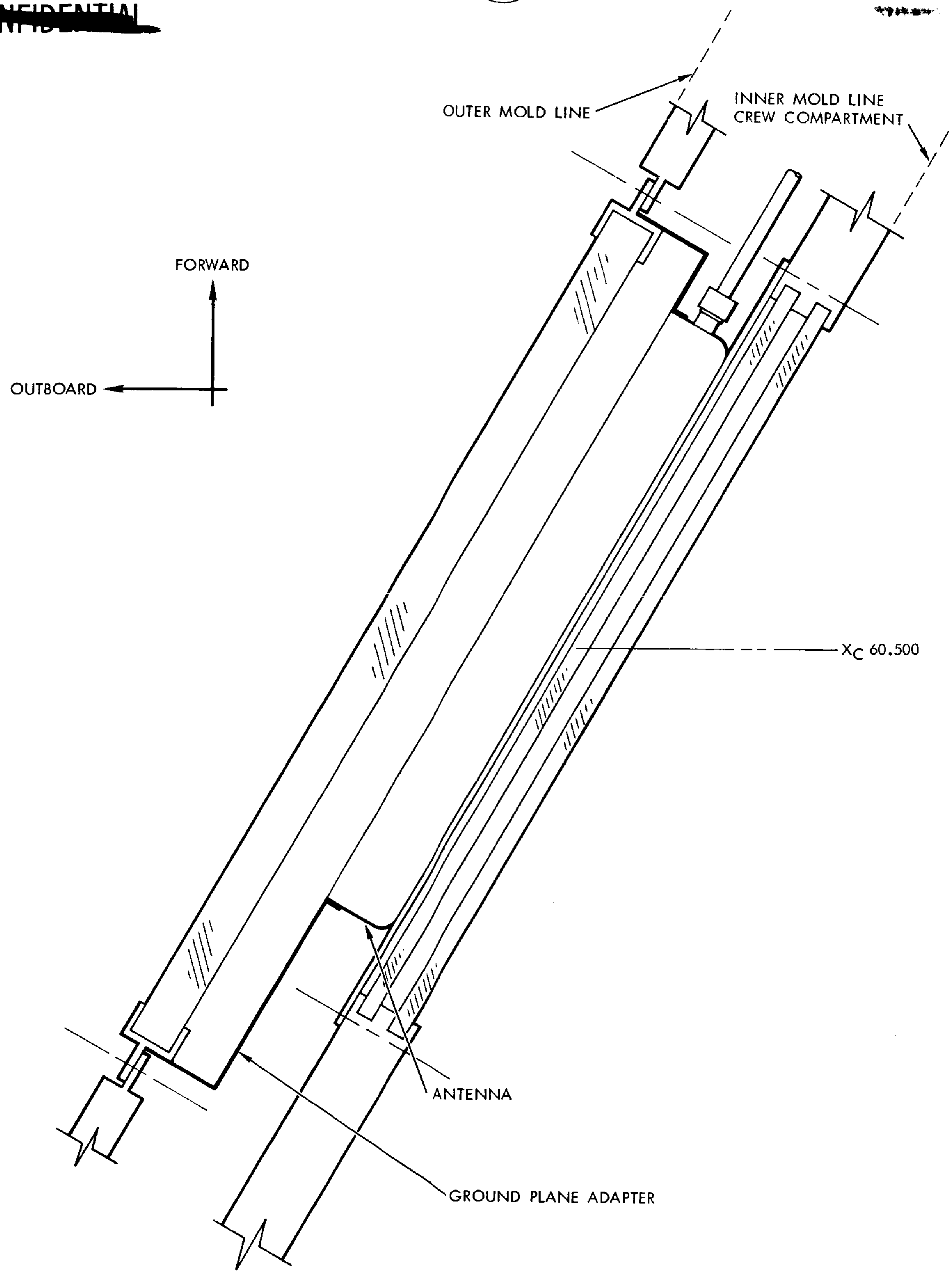

Figure 3. VHF Cavity Antenna, Recovery Backup

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Fabrication is on schedule for the wind tunnel tenth-scale model, to be used to determine the heating of spacecraft protuberances. The conical section is ready for the windows and tower wells, and the aft heat shield was sent to the subcontractor. The tests are scheduled to start in mid-June at the Ames Research Center. The testing schedule will include additional angles of attack and yaw angles. A total of 181 tests are planned, including oil flow visualization studies.

The command module measurement lead cable of spacecraft 008 will be routed externally to the service module for the environmental chamber tests at NASA-MSC. A support will be erected on the lunar plane located within the chamber and will extend to the top of the command module. The instrumentation leads and other GSE lines will be attached to the support and will be routed through the lunar plane.

ELECTRICAL POWER SUBSYSTEM (EPS)

Machining problems on the Inconel 718 pressure vessels were solved by the Airite Corporation. The first vessel was welded successfully and delivered to Beech Aircraft Company.

The cryogenic gas storage vessels successfully met the heat leak requirements. The hydrogen storage tank now meets the heat leak rate of 7.7 Btu per hour. The oxygen tank was previously qualified.

The prototype of the inverter was completed by Westinghouse. Acceptance testing is under way.

The Parker Aircraft fuel cell valve modules for hydrogen and oxygen successfully passed acceptance tests at Beech Aircraft Company.

To support schedules, incandescent lamps will be used for command module floodlighting because of difficulties in qualifying the quartz iodine lamps.

Qualification testing of the general purpose connectors made by Cannon Electric is to begin in the latter half of May. Difficulties encountered with the insert material at low temperatures had caused delays. Qualification testing of the bulkhead feedthroughs is scheduled to begin on May 25.

PROPULSION SUBSYSTEM

Service Propulsion Subsystem (SPS)

Block II studies of the SPS are in progress. With a reduction in propellant capacity and tank pressure and a change in the feed subsystem from series to parallel configuration, a lower spacecraft weight is possible. SPS vernier engines and cryogenic helium storage are also being investigated as optional changes.

Brazing problems of the SPS plumbing were resolved by limiting brazing to lines 1/4 inch to 3/4 inch in diameter and welding lines 1 inch and larger in diameter. An SPS check valve was cycled twice daily over a 15-day period in a 100 F environment to complete the oxidizer compatibility test; both oxidizer compatibility and leak specification requirements were satisfied. Cold-flow testing of the SPS test fixture F-3 was completed, and the fixture is being readied for shipment to AEDC.

Twelve firings were accomplished at Aerojet and AEDC in the Phase I development testing completed April 14. A sustained firing of 635 seconds, in a series of 7 firings totaling 751 seconds, was accomplished on engine AEDC 0003. This test demonstrated the SPS engine capability for long-duration firing at high altitude during a simulated translunar abort maneuver.

The SPS dynamic stability program was begun with 12 firings of the first all-welded, 6-baffle injector. The injector is being reworked to eliminate an interpropellant leakage discovered during these tests.

Table 2 lists all SPS engine firings made during this report period.

Reaction Control Subsystem (RCS)

The first of the Phase IIA breadboard tests of the service module RCS was begun; subsystem leak tests and component functional tests were performed (see Figure 4). The low-pressure portion of the RCS was found to be leakproof at 331 psig.

Two service module RCS fuel tank bladders underwent 50 expulsion cycles successfully using revised propellant evacuation and helium vent-off procedures.

S&ID, NASA, and Grumman met at Marquardt on April 16 to conduct a technical review of the service module RCS program. Major accomplishments during the report period were the elimination of the hot-phase burning and the lowering of the chamber wall temperature from 2900 F to approximately 2500 F.

The first environmental test sequence on a command module RCS prototype engine is nearing completion. The engine was subjected to a 78-g landing shock in each of three mutually perpendicular axes. A second engine of prequalification configuration has successfully completed the first half of an environmental test sequence.

[redacted]

Table 2. Apollo SPS Engine Test Program

Serial Number	Pattern Type	Type of Evaluation	Number of Firings, Ablative Chamber	Time (sec)	Number of Firings, Steel Chamber	Time (sec)	Number of Engine Firings	Time (sec)	Remarks
AFF-27	POUL-31-39	600-cps investigation	3	673					Satisfactory
AFF-28	POUL-31-47	600-cps investigation	5	244	2	11			Chamber pressure survey
AFF-34	PONX-51-11	Performance			1	4			Satisfactory
AFF-32	POUL-31-43	600-cps investigation	4	236	4	15			Satisfactory
AFF-29	POUL-31-44	600-cps investigation			4	18			Satisfactory
AFF-78	POUL-31-10	Acceptance	1	31	6	35			Severe streaking-injector rejected
0007	Engine assembly (AFF-54) POUL-31-10	Checkout Mission duty cycle					1 4	11 437	Low mixture ratio Satisfactory
6-4-2 Serial number 16	POUL-41-21	Dynamic stability	5	458	7	39			Gouging noted and sporadic chamber pressure blips
AEDC 0003	Engine assembly (AFF-23) POUL-31-10	Simulated high altitude					7	751	Abort duty cycle-chamber failed during last 2-second firing

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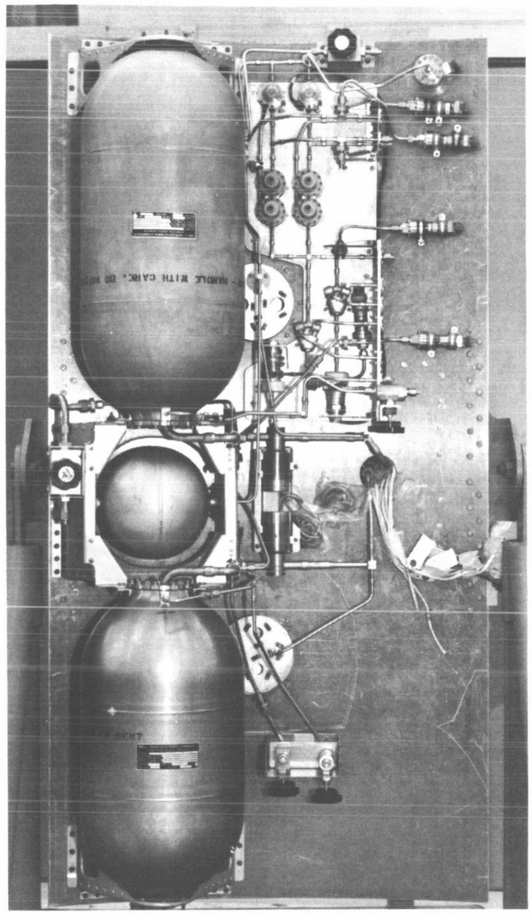

Figure 4. Service Module RCS
Breadboard, Leak Test

Launch Escape Subsystem Motors

Two tower jettison motors, each having larger nozzle throat areas and modified pyrogens, were successfully fired during this report period. These two motors were originally intended to be the first two qualification motors. However, the addition of the boost protective cover to the command module imposes a requirement for a tower jettison motor with a greater thrust vector angle. Therefore, these two motors were reassigned as development motors and were fired to verify predictions for boilerplates not using the boost protective cover. The thrust vector angle increase will be from the present design of 2.5 degrees to 3.8±0.3 degrees.

S&ID directed Thiokol to begin the design of a nozzle for the tower jettison motor that will produce 3.8±0.3 degrees of thrust vector in sea-level firings and a maximum of 4.4 degrees in simulated-altitude firings.

The first two LES motors intended for qualification testing were cast during this report period. Qualification tests are scheduled to begin in early June.

Propulsion Subsystem Analysis

Preliminary evaluation of data from four SPS engine test runs conducted at AEDC shows engine specific impulse values of approximately 308 to 317 seconds. Each of the four runs used a mixture ratio ranging from 1.8:1 to 2.3:1.

Calculation shows that, with the extreme valve control positions, the present design of the propellant utilization valve provides an oxidizer imbalance correction rate of 1.45 pounds per second and a fuel imbalance correction rate of 0.75 pounds per second. These values reflect a reduction in control capability of the propellant utilization valve of approximately 18 percent because of changes in the propellant feed subsystem. The propellant utilization valve correction capability is considered adequate for the 45,000-pound propellant subsystem, but further study is required for a reduced amount of propellant.

DOCKING AND EARTH LANDING

Flotation tests on boilerplate 1 were completed successfully on April 27. The tests were conducted to determine the flotation characteristics of the command module and to observe oscillation and damping amplitude.

Six main-parachute drop tests were conducted at El Centro during this report period. These tests were performed to develop a means of slowing the disreef opening time and to reduce blanketing of the main chutes in a cluster. It was concluded previously that midgore reefing and removal of a portion of a ring in the crown of the canopy improved performance. Preliminary analyses of these tests confirmed this prediction; a large reduction in oscillations and a substantial reduction in opening loads resulted. The tests will continue for the purpose of determining optimum opening characteristics and minimum loads. Figure 5 shows three views of the mock-up of the command module parachute deck. The three main parachutes and other earth landing subsystems are shown.

Preliminary design of the mission sequencer to be used in manned space flight was initiated, using relays as logic circuitry. Preparation of the sequencer schematic is in progress. Vibration tests are being conducted to determine the most reliable relays. Motor switches are being subjected to 25-cycle run in tests to reduce excessive transfer time caused by a slight adhesion between brake lining and brake disc.

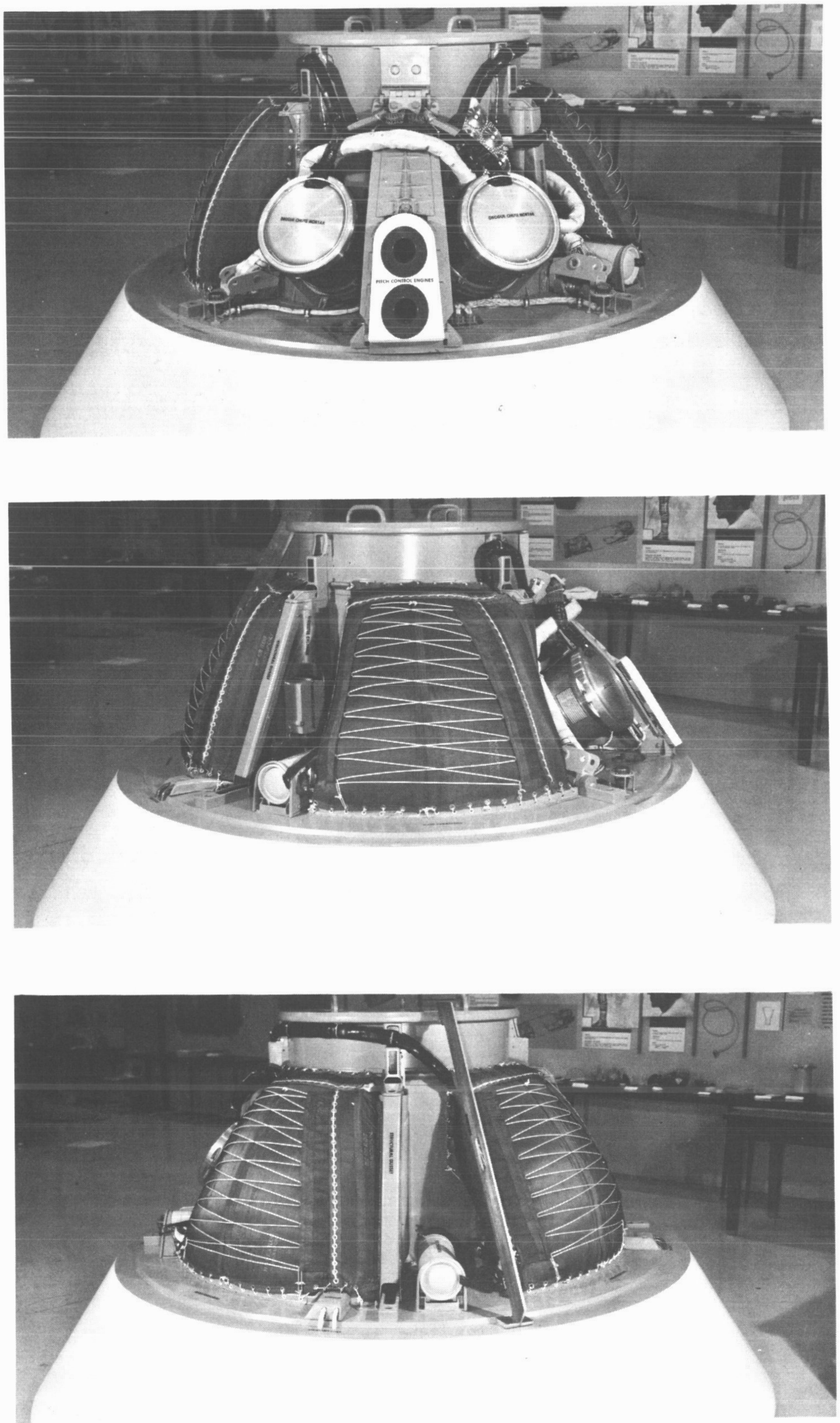

Figure 5. Mock-up of Command Module Parachute Deck

GROUND SUPPORT EQUIPMENT

Acceptance Checkout Equipment (ACE-SC)

Initial coordination and design review meetings conducted with Control Data Corporation revealed that progress is being made on the digital test command subsystem (DTCS), and the delivery schedules should be met.

Engineering evaluation of proposals to establish a second source for the pulse code modulation subsystem has been completed. The present subcontractor has been unable to meet schedule requirements.

A redesign of the high-sampling-rate signal conditioning unit eliminated 11 signal conditioning modules with resultant cost savings. A study of the "Mechanical Boy" measurement interfaces shows that approximately 10 signal conditioner modules can be eliminated after minor changes.

Special Test Units

The first quarterly report on measuring requirements for the special test units (STU) was published. The report provides a single reference source for measurement parameters during subsystem checkout when controlled by the STU's.

Auxiliary and Substitute Units

The test conductor console was modified to include the following:

1. An abort timer audible alarm control

2. A visual abort timer monitor

3. A GSE emergency backup power supply with automatic conversion to this supply in the event of failure of GSE primary power supply

A proposal to NASA is being prepared to eliminate the requirement for the inverter substitute unit to supply 400-cps power at the various facilities. Design requirements indicate that a maximum of 360 VA is necessary to operate the service module fuel cell pumps. Because of the power tolerances, facility power is more than adequate. If the proposal is adopted, reductions can be made in the size, weight, and cost of the inverter substitute unit, and the unit will not be required to operate in a hazardous area near the launch pad.

The following items of auxiliary and substitute equipment were accepted by NASA in the March-April concept review:

Fuel cell substitute unit
Pyrotechnic initiator substitute unit
Command module substitute unit controller
Service module substitute unit controller
Spacecraft power supply

All engineering drawings for the checkout subsystem verification set and the inverter substitute unit were released during this report period.

Spacecraft Instrumentation Test Equipment (SITE)

Manufacture of the SITE control console was completed by Autonetics, and the console was successfully power tested at S&ID.

Cable drawings were released to support SITE testing for spacecraft 006 flight equipment. A preliminary study was made of the full English language compiler, Comsite II, which can keypunch directly from the absolute test process specification. Use of Comsite II will significantly reduce SITE control console programming time.

Servicing and Checkout GSE

The requirements for cooling and purging the service module using gaseous nitrogen and/or air were defined. They will be submitted for approval at the next S&ID-NASA meeting of the propellants and gases sub-panel. The fluid requirements chart is 98 percent complete.

A letter contract was given to the Shawnee Industries Division of Thiokol to design and fabricate a GSE helium-ready storage container.

Engineering drawings were released during this report period for the following models:

Fuel cell radiator substitute unit
Fluid disposal adapter set for the RCS nozzles
Anthropomorphic dummy litter
Weight and balance cable and fitting set
Integrated test support base for the service module
ECS umbilical tower

The following GSE equipment has been delivered to test sites to support the spacecraft program:

SPS engine sling
Ethylene glycol water transfer unit
Water-glycol cooling unit (see Figure 6)
Ethylene glycol fluid trim control unit
Toxic vapor disposal units for fuel and oxidizer
Thrust vector control set
Engine on-off control set

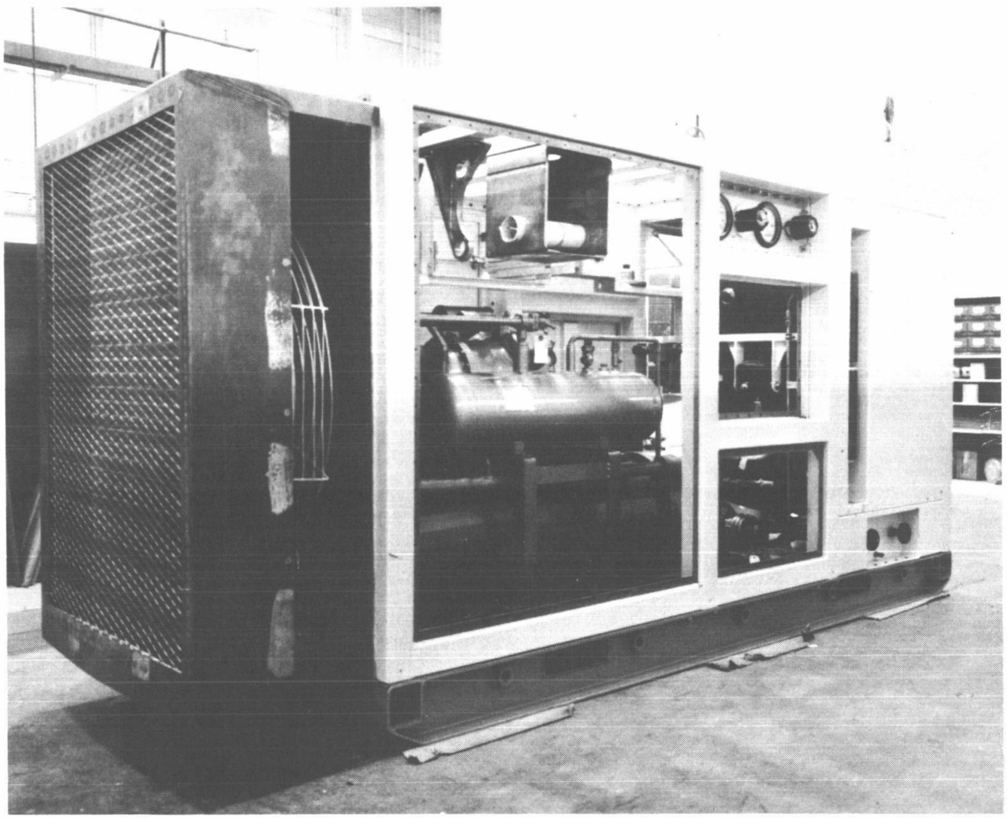

Figure 6. Water-Glycol Cooling Unit

SIMULATION AND TRAINERS

The visual display subsystem for docking simulation Study C to be conducted at NAA-Columbus is being upgraded by the addition of Eidophor television projection equipment into the Columbus visual subsystem. The Eidophor equipment will be installed and checked out for the beginning of the study; the computer mock-up visual subsystem checkout was completed on May 15. Simulation runs are scheduled for May 18 and 19 to familiarize the three pilot subjects with the controls and displays. Production runs are scheduled to begin May 20.

The Entry 2 engineering simulation studies became operational on evaluator E-1 on May 15, with the first series of runs being made to analyze manual override of the entry G&N subsystem. This simulation study is a 6-degrees-of-freedom problem having a dynamic range following command module-service module separation from an altitude of 7,000,000 feet down to drogue deployment at 25,000 feet with a velocity varying from 36,000 to 1000 fps. Tumbling of the command module can be simulated at rates up to 1 radian per second. The complexity of this study required that trajectory equations, quaternions, and G&N guidance logic be programmed on a medium-size digital computer and that the remainder of the problem be programmed on general-purpose analog computers. The computers were tied in with evaluator E-1 through interface hardware. Successful checkout of Entry 2 is a major milestone in the engineering simulation program. It marks the first operational hybrid study tied in to an evaluator.

A design review on the Apollo subsystem trainers was conducted at the NAA Los Angeles Division on April 23. A detailed briefing covering the trainers was presented on the mechanical, electrical, and spacecraft subsystems displays. A working, lighted-line mock-up of a typical trainer display panel was demonstrated.

VEHICLE TESTING

Boilerplate 12 integrated subsystems testing was successfully completed on May 6. Flight readiness review was held, and final preparations for launch were completed on May 12. A successful launch was accomplished on May 13.

Boilerplate 13 was mated with the Saturn-Apollo launch vehicle on pad 37 at KSC. All checkout tests were completed satisfactorily.

Boilerplate 15 is in test preparation; the addition of nonoperating prototype RCS engines and instrumentation is in progress.

Installation and inspection of the secondary structure of spacecraft 001 was completed. Four SPS propellant tanks were installed. The mock-up of the helium plumbing is approximately 40 percent complete. A major portion of the EPS and cryogenic gas storage subsystem mock-up plumbing was inspected; it will be used for the fabrication of the actual spacecraft plumbing. RCS panels were fit-checked on the vehicle. All electrical wiring diagrams required to update the basic wire harness were completed.

Bonding of tees, angles, and channels to the command module forward and aft crew compartment sections of spacecraft 006 was completed. Final welding of these sections is in progress.

RELIABILITY

Block II Spacecraft Configuration Studies

A reliability study of the proposed Block II spacecraft configuration was completed.

The concept of no in-flight maintenance requires additional redundancy in order to meet reliability requirements. Added redundancy will be built into the SCS. The communications subsystem will require redundant pulse code modulators and redundant S-band equipment.

The provision of one universal-type spare gyro for the SCS rate gyros and one for the SCS body-mounted attitude gyros instead of complete spare gyro packages will save 15 pounds. Each of the two spare gyros can be used to replace a failed pitch, roll, or yaw gyro in the SCS subsystem for which each is spared.

The Block II electronic configurations will have a slightly lower predicted reliability than apportioned. However, since the Block II reliability study for electronics was based on conservative failure rates that are higher than expected, the proposed configuration for Block II electronics is considered to have acceptable reliability.

The proposed addition of four vernier rocket engines clustered about the aft section of the large SPS engine will provide backup for the large SPS engine in any abort, including one from lunar orbit. In addition, the service module RCS would be improved because of increased capabilities in pitch and yaw control and propellant settling. The redundancy provided by the four vernier engines results in a significant increase in crew safety by two orders of magnitude. However, emergency shutoff valves are required to prevent propellant leakage during long coast periods. Signals to these valves can originate from the propellant quantity measuring subsystem and/or the instability cutoff devices.

Analysis of the present SPS large engine plus the four vernier engines showed that six of the eight start valves could be eliminated if two emergency shutoff valves were added. The two remaining ball start valves, powered by one electric actuator, are redundant to the two emergency valves to stop possible leakage, because the former are connected in series with the latter. This simplification of the valve subsystem improves reliability and increases the probability of mission success.

Boilerplate 13 Flight Readiness Reliability Status

Boilerplate 13 is ready for launch, contingent upon the successful completion of all preflight electrical checks within specified tolerances. This conditional reliability recommendation stems from the existence of a number of potential single-point failures in GFE electrical power and telemetry equipment, and actual failures encountered with the furnished on-board "A" batteries. Since the primary mission of boilerplate 13 is to gather and transmit flight data to earth, a failure in the "A" battery (used for instrumentation) or the power control box relays would result in the Apollo portion of the mission not being achieved.

An analysis of motor switches showed that excessive time-out is an inherent characteristic of the Model 939 Kinetics motor switch following high-temperature cycling. These switches are to be used "as is" on boilerplates 12 and 13, provided that no temperature change greater than 35 F is experienced by the switches in the period from the last checkout cycle to the time of launch.

Design Review of the Toxic Fuel Dispersal Unit

A design review was held on the toxic fuel dispersal unit. The specification is being revised to call for a larger, more realistic horsepower rating than the present 30 hp specified for the electric motors which power the dispersal unit. The use of tower stacks versus the present wind machine for toxic vapor dispersal is being evaluated also. A study is being made of the use of remotely controlled solenoid shutoff valves in place of the present manual valves located inside the unit. The remote control valves are expected to facilitate maintenance, increase reliability, and ensure personnel safety.

TECHNICAL OPERATIONS

Sixteen contract changes authorized by NASA during this report period are being implemented by S&ID. The following four changes were considered the most significant:

Service Module Destruct Subsystem

A service module destruct subsystem for propellant dispersal is being designed as a range safety measure (see Figure 7). The destruct subsystem will be operable only during the time between lift-off and tower jettison and in the event of an abort. At the moment of tower jettison an interlocking switch operates to prevent subsequent arming. Propellant dispersal will be accomplished by detonating four conical shaped explosive charges

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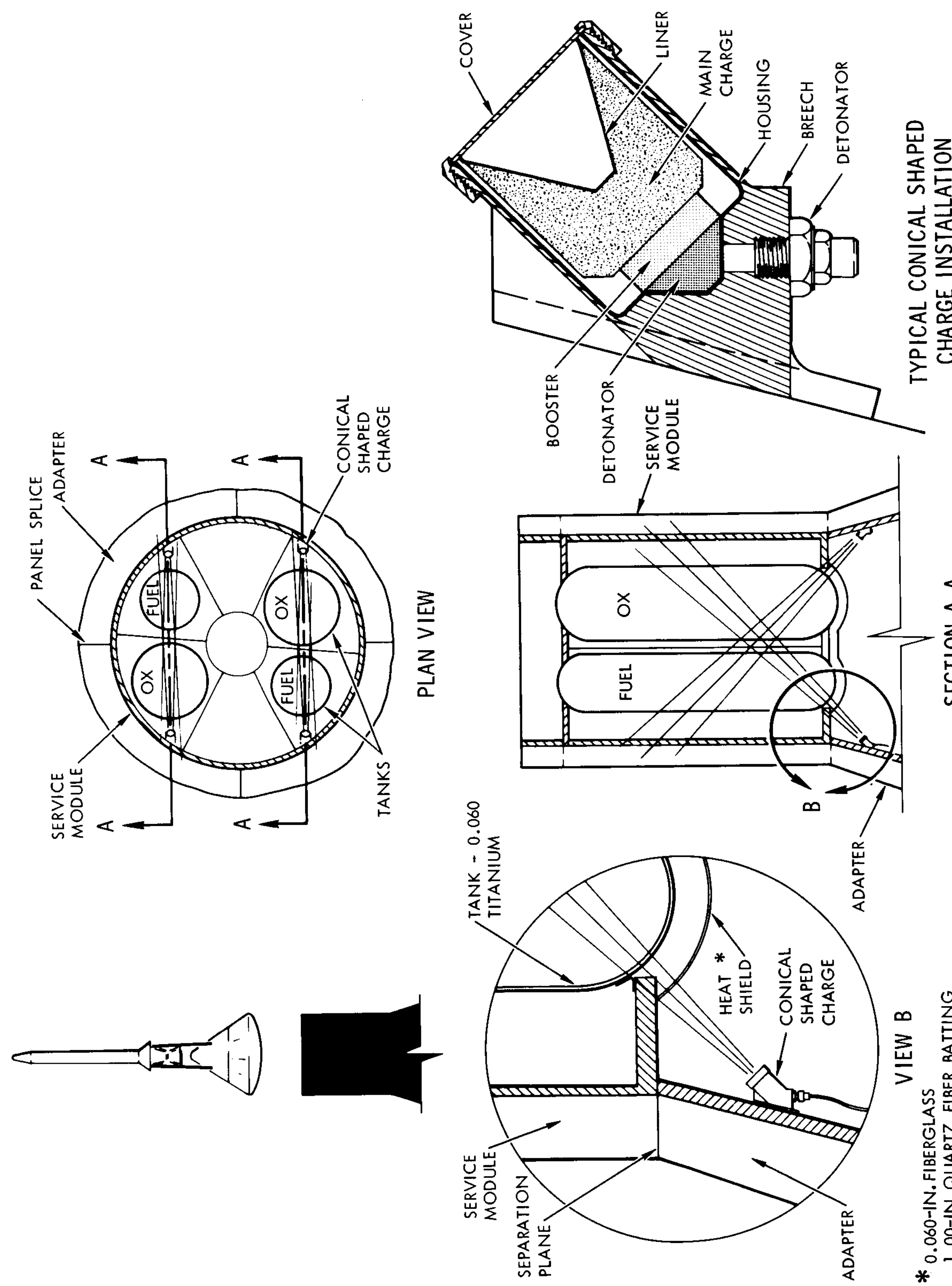

Figure 7. Service Module Destruct Subsystem for Propellant Dispersal

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installed on the frame of the S-IVB adapter just below the service module propellant tanks. Each charge will be aimed at a pair of fuel and oxidizer tanks and will have sufficient explosive force to pass completely through one tank and penetrate the second. The resultant holes will cause the two hypergolic propellants to mix; immediate ignition will occur, and the propellants will be consumed.

The subsystem will be armed and fired by a pair of radio command receivers and decoders. Redundancy exists both in explosive charges and electrical circuitry.

Interlock switches prevent arming of the circuits on the pad and reception of the detonating signal prior to separation of the service module from the command module. An arming signal can be transmitted by the emergency detection subsystem or by radio from the range safety officer. In a normal mission the destruct subsystem is in a safe and unarmed condition at all times.

Space Suit Umbilicals

Changes will be made in the space suit umbilicals so that the connectors on both ends of each will be identical Hamilton Standard configuration and therefore functionally interchangeable. The command module suit flow-valve receptors will be made compatible with these connectors. The same umbilicals can also be used to connect to the portable life support subsystem (PLSS). One of the umbilicals to be used by the two astronauts who will transfer from the command module to the lunar excursion module will have an on-off safety valve to permit "buddy system" operation. Thus, in the event one PLSS fails, the umbilical with the on-off valve can be used to plug into the other PLSS supply, which will then serve both astronauts during such an emergency.

Dynamic Combustion Stability of SPS Engine

Dynamic combustion stability of the SPS engine will be provided by redesign of baffles and injector. This change will permit the engine to recover from self-induced and externally caused instability.

Deletions

Deletion of the command module RCS and SCS from boilerplate 22 and spacecraft 002 is provided. Also, the elimination of crew couches, anthropomorphic dummies, and all related instrumentation from spacecraft 002 and 010 is authorized.

OPERATIONS

DOWNEY

Boilerplate 15

Updating and modification were completed on the command and service modules of boilerplate 15. Checkout of the VHF omni-antenna and the radar beacon console was completed. The electrical power subsystem functional checkout, the initial environmental control subsystem checkout, the adapter shakedown inspection, and the GSE water-glycol cooling unit checkout and validation were completed. The telemeter and communications systems checkout was accomplished, and the shakedown inspection of the boilerplate 15 components was completed.

The static test tower facility was prepared for testing of boilerplate 15 by the installation of a support base. The stacking of insert, adapter, service module, and command module was completed on May 14. Preparations for integrated testing in the stacked configuration were initiated.

The GSE integrated testing was completed, and the GSE was installed in the tower facility. A cabling checkout was completed on May 15.

Mission readiness testing will be completed for boilerplate 15; the entire vehicle and some associated GSE will be shippped to the Florida facility (FF) during the next report period.

The boilerplate 12 GSE, which is to be returned from WSMR, will undergo modification and reverification for use with boilerplate 23 testing.

WHITE SANDS MISSILE RANGE

Mission Abort

The boilerplate 12 launch escape subsystem sequencer bench checks, installation, and functional verification were completed in time to perform the inspection and open item review on April 27. Subsequent activities were completed as programmed—including the Little Joe II launch vehicle interface test, the integrated systems test, the simulated countdown, the abbreviated integrated systems test, the open item review, and the flight readiness review. High wind and dust conditions caused postponement of the launch operations on May 12. Boilerplate 12 field operations were climaxed by the launch at 6 a.m. MST on May 13.

[redacted]

Following Little Joe II lift-off, the boost phase appeared normal with a definite thrust termination. At abort initiation, the launch escape motor appeared to fire satisfactorily, moving the command module clear of the Little Joe II and the service module. Jettison motor ignition and launch escape tower separation occurred simultaneously; the LES followed a free-fall trajectory to earth impact. In proper sequence, the drogue-parachute deployment and release, pilot-chute deployment, and main-parachute extraction appeared to operate satisfactorily. After extraction, one main chute separated without deploying. The command module landing was accomplished with only two main chutes inflated. Impact occurred at 6:06 a.m. MST (see Figure 8).

All flight hardware specified in the recovery plan was recovered and returned to the WSMR vehicle assembly building for post-launch operations.

Boilerplate 12 post-launch operations will be completed during the next report period, and the boilerplate 12 GSE will be returned to the Downey facility.

Propulsion Systems Development Facility (PSDF)

The over-voltage testing of the PSDF data acquisition system (DAS) voltage control oscillator was completed. The DAS voltage control oscillator static linearity and drift tests and the DAS discriminator static linearity and output stability tests were completed. The instrumentation tape-transport servo-speed test and the analog tape frequency response tests were completed.

The output sampling and validation of the helium compressor were completed.

The test fixture F-2 engine arrived at the PSDF, and receiving inspection was completed.

The installation of the test fixture F-2 fluid distribution system will be completed,and the system will be cleaned during the next report period. The functional and leak checks of the propellant portion of the test fixture will be completed.

Installation and checkout of transducers on the test fixture engine and the functional and leak checks of the engine will be accomplished. The engine will be installed in test fixture F-2.

Tests of DAS voltage control oscillator frequency response, harmonic distortion, and time correlation will be performed.

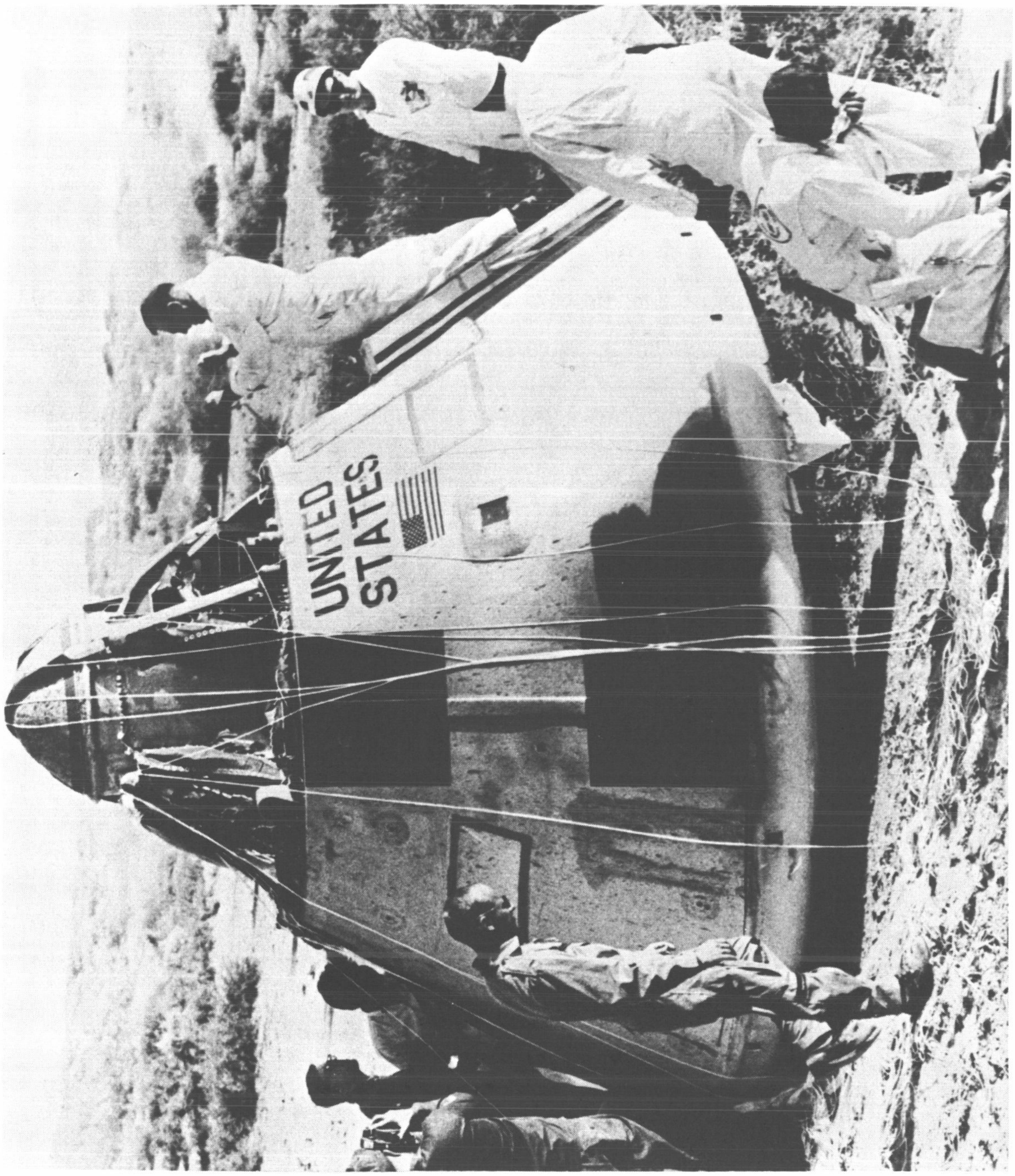

Figure 8. Boilerplate 12 Command Module After Impact, White Sands Missile Range

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FLORIDA FACILITY

Boilerplate 13

The Boilerplate 13 spacecraft-launch vehicle electrical interface test was completed in coordination with NASA-KSC launch personnel. The test ran normally throughout the entire mission simulation. The spacecraft-launch vehicle radio frequency interference (RFI) checks were completed. The RF compatibility between spacecraft and launch vehicle, as well as the range, was verified. The spacecraft simulated flight (swing-arm over-all test) was completed, and proper operation of the swing-arm was verified during a spacecraft simulated mission. The LES sequencer operated successfully in both of these tests.

The spacecraft-launch vehicle over-all test 1 (plugs in) was completed. This was the first test conducted with special recording equipment replacing the pyro substitute unit. Prior to running over-all test 2, the ECS was reworked. The first test (plugs out), which repeated portions of an earlier test, was completed with only minor problems. The launch vehicle fired live ordnance, and the umbilical was blown. Special recorder data indicated that spacecraft pyro lines were clear of transients. The second test (plugs out) was completed late the same day. The spacecraft fired its test ordnance, and the umbilical was blown. The test was successful.

The end of field operations for boilerplate 13 was extended for six days by NASA-KSC because of launch vehicle problems. Accordingly, the final over-all test was also rescheduled.

Boilerplate 15 will arrive at the Florida facility early in June. Preparation for receipt of this boilerplate will continue at Hangar AF.

TEST PROGRAM SUPPORT

The physical installation of the main Apollo data system at the Apollo data processing laboratory (ADPL) was completed. The power and signal cables were connected, and checkout of the system was initiated. The supplier, Radiation Incorporated, has completed the unit system and sub-system testing. S&ID is using the computer portion of the data system for checkout of the stored program decommutation assembler and leader on a noninterference basis. The system is also being used to process previously reduced data in order to gain system familiarity and establish a higher degree of confidence.

A representative of the S&ID Apollo Test and Operations pilot research unit participated in a comparative evaluation of the Apollo space suit versus

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the Gemini space suit. The results of this evaluation indicate that, from the subject's viewpoint, the Gemini space suit afforded improved mobility, vision envelope, and comfort.

Data support will be provided for the launch and flight of boilerplates 12 and 13, including post-flight activities. Data support will be initiated for the field operations of boilerplate 15 and test fixture F-2 during the next report period.

Acceptance testing of the main Apollo data system will be completed at ADPL.

FACILITIES

DOWNEY

Service Module Pressure Test Cell

The service module pressure test cell was completed on May 4. This is a 32-foot-by-25-foot-by-25-foot pit type test cell, isolated from existing buildings to allow pressure testing, leak testing, and associated functional testing of installed plumbing and tankage in the Apollo service module.

Systems Integration and Checkout Facility

The installation of the foundations for the ground service equipment was completed on May 8, two weeks ahead of schedule, except for removing the form work in the tunnel. Installation of the acceptance checkout equipment dais was completed on May 8, four days ahead of schedule. Installation of ACE grounding, power distribution, air conditioning, and partitions continues.

Impact Test Facility Enlargement

A plan to enlarge the impact test pool by 3600 square feet has been approved by NASA. This modification will accommodate the revised test requirements established by NASA, which increase the maximum horizontal velocity from 35 fps to 48 fps and specify other test conditions associated with water impact as the primary mode for earth landing.

INDUSTRIAL ENGINEERING

Apollo Mock-up Display and Design Engineering Inspection (DEI)

A PERT network has been set up for the planned display of mock-ups and the DEI area in Building 1. Design and construction has been broken down in two phases. The first phase, consisting of the early construction of the north and west walls and the refurbishment of the floor, is scheduled for completion on June 5, 1964. The area will be available for occupancy by the lunar excursion module mock-up at this time. The second phase includes the briefing room, rest room facilities, and air conditioning. This phase is scheduled for completion on July 31, 1964.

Additional Autoclave

The procurement specification for an 8-foot-by-12-foot autoclave for the bonding building has been written. This autoclave will be used for bonding smaller inner crew compartment secondary structures so that the two large autoclaves can accommodate the scheduled work loads for large structures.

APPENDIX

S&ID SCHEDULE OF APOLLO MEETINGS AND TRIPS

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S&ID Schedule of Apollo Meetings and Trips
April 16 to May 15, 1964

Subject	Location	Date	S&ID Representatives	Organization
"Mechanical Boy" design discussion	Houston, Texas	April 16 to 17	Kalayjian, Conrad, Henke	S&ID, NASA
Apollo mission simulator (AMS) IMU requirements, discussion	Houston, Texas	April 16 to 17	Smith	S&ID, NASA
AMS digital programming review	Teaneck, New Jersey	April 16 to 17	Robertson, Shoytush, Fairchild	S&ID, Link-Computronics
Environmental control subsystem and waste management system, discussion	Houston, Texas	April 16 to 17	Stoll, Ross, Palmer	S&ID, NASA
Boilerplate 13 sequencer, delivery	Cocoa Beach, Florida	April 16 to 20	Litsikas	S&ID, KSC
Crew safety panel working group meeting	Huntsville, Alabama	April 17 to 21	Geheber, Gordon, Barmore	S&ID, MSFC
Boilerplate 12 preflight field testing, supervision	Las Cruces, New Mexico	April 18 to May 23	Jackson	S&ID, WSMR
Boilerplate 13 launch flight report requirements coordination	Cocoa Beach, Florida	April 19 to 21	Ryan	S&ID, FF
Electrical subpanel of launch operations panel, meeting	Cocoa Beach, Florida	April 19 to 21	MacArther, Quebedeaux	S&ID, KSC
Boilerplate 13 flight test report requirements coordination	Cocoa Beach, Florida	April 19 to 22	Cole	S&ID, KSC
Boilerplate 12 sequencer installation	Las Cruces, New Mexico	April 19 to 23	LaMont	S&ID, WSMR
Coordination of TV coverage of Boilerplate 13 launch activities, review of inputs to boilerplate 15 detailed test plan	Cocoa Beach, Florida	April 19 to 24	Johnson, Krupp	S&ID, NASA
Project engineering coordination	Sacramento, California	April 20 to 25	Borde, Mower	S&ID, Aerojet
Boilerplate 13 and 15 launch support	Cocoa Beach, Florida	April 19 to May 2	Dorman	S&ID, FF
Pad operations support	Cocoa Beach, Florida	April 19 to May 2	Linsday	S&ID, FF
Boilerplate 12 data engineering support	Las Cruces, New Mexico	April 19 to May 3	White	S&ID, WSMR

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S&ID Schedule of Apollo Meetings and Trips
April 16 to May 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Supplier surveys for procurement	Jackson, Michigan	April 20	Robson, Johnson, Chambers	S&ID, Mechnical Products
Supplier surveys for procurement	Attleboro, Massachusetts	April 20	Robson, Johnson, Chambers	S&ID, Metals & Controls
Change proposals, contract renegotiation	Joplin, Missouri	April 20 to 22	DeVries, Briggs, Parry, Otzinger	S&ID, Eagle Picher
Coordination meeting	Cedar Rapids, Iowa	April 20 to 22	Blakeley, Yui	S&ID, Collins
Wind tunnel test coordination	Houston, Texas	April 20 to 22	Allen, Takvorian	S&ID, NASA
Supersonic dynamic stability, discussion	Cleveland, Ohio	April 20 to 22	Allen, Takvorian	S&ID, Lewis Research Center
Boilerplate 12 coordination	Las Cruces, New Mexico	April 21 to 22	Pearce	S&ID, WSMR
Service propulsion subsystem support	Las Cruces, New Mexico	April 20 to 23	Milam	S&ID, WSMR
ACE coordination	Cocoa Beach, Florida	April 21 to 24	McArthur, Sayed	S&ID, KSC
Boilerplates 13 and 15, support	Cocoa Beach, Florida	April 20 to Sept 30	Everett	S&ID, KSC
DART mission coordination	Washington, D. C.	April 21	Hogan, Marelia, Reiss, Beck	S&ID, MIT Bellcomm
Witnessing of initial tests	Goleta, California	April 21	Jones, Richardson	S&ID, General Motors
Dynamic motion simulator program management review	Shawnee, Oklahoma	April 21 to 22	Carter	S&ID, Shawnee Industries
Witnessing of design verification testing (DVT)	San Carlos, California	April 21 to 22	Sztukowski	S&ID, Pelmec, Division Quantic Industries
Flight table status review	Shawnee, Oklahoma	April 21 to 23	Rovelsky	S&ID, Shawnee Industries
Thrust vector control (TVC) analysis, meeting	Minneapolis, Minnesota	April 21 to 23	Tutt, Jansen, Oglevie, Witameer	S&ID, Minneapolis-Honeywell
Engineering and purchasing meeting	Shawnee, Oklahoma	April 21 to 24	Brown	S&ID, Shawnee Industries
Cost negotiation	San Carlos, California	April 21 to 24	Langager, Lazarus, Sztukowski, Spritzler	S&ID, Pelmec

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S&ID Schedule of Apollo Meetings and Trips
April 16 to May 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Acceptance checkout equipment, monthly coordination meeting	Minneapolis, Minnesota	April 21 to 24	Stady	S&ID, Minneapolis-Honeywell
Witnessing of development tests	San Carlos, California	April 21 to 24	Lazarus	S&ID, Pelmec
Propellant utilization and gauging, system design review	Tarrytown, New York	April 21 to 29	McKeller, Akers	S&ID, Simmonds
Design verification test program, coordination meeting	Rocky Mount, Virginia	April 21 to May 2	McKeller	S&ID, Thompson Ramo Wooldridge
Observation of parachute drop test	El Centro, California	April 21 to May 18	Close	S&ID, Northrop-Ventura
Engineering coordination	Middletown, Ohio	April 22 to 23	Chadbourne, Johnson	S&ID, Aeronca
DART coordination meeting	Washington, D. C.	April 22 to 23	Fouts, Shanahan	S&ID, Bellcomm
Meteoroid shielding meeting	Houston, Texas	April 22 to 23	Jones	S&ID, NASA
Block I mock-up review	Houston, Texas	April 22 to 23	Pyle	S&ID, NASA
Mock-up review presentation	Houston, Texas	April 21 to 24	Karl, Gillmore, Cureton, Opdyke, Brewer	S&ID, NASA
Hermetically sealed switches, design and documentation	Seattle, Washington	April 22 to 24	Hoyt	S&ID, Korry
Review site activation problems	El Paso, Texas	April 22 to 24	Porter	S&ID, WSMR
Final design review	Raleigh, North Carolina	April 22 to 25	Harcourt, Young, Large	S&ID, Electric Storage Battery
Pyrotechnic substitute unit, technical discussion	Houston, Texas	April 23 to 24	Chiapuzio	S&ID, NASA
Pyro test equipment review	Houston, Texas	April 23 to 24	Necker	S&ID, NASA
Crew systems materials discussion	Houston, Texas	April 23 to 24	Drysol	S&ID, NASA
Service propulsion subsystem, coordination	Sacramento, California	April 23 to 24	Fow	S&ID, Aeroject
Boilerplate 12 support	Las Cruces, New Mexico	April 23 to May 4	Gibson	S&ID, WSMR

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S&ID Schedule of Apollo Meetings and Trips
April 16 to May 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Automated systems for unmanned spacecraft, briefing	Houston, Texas	April 26 to 27	Rzyski, Levine, McCarthy, Fouts, Hogan Shannahan	S&ID, NASA
Apollo guidance and performance subpanel meeting	Houston, Texas	April 26 to 28	Schall	S&ID, NASA
Preliminary design review	Sunnyvale, California	April 26 to 28	Farr, Hardaway	S&ID, Thermatest Laboratories
Service propulsion subsystem test fixture review	Sacramento, California	April 26 to 29	Carlson, Johnson, Pastizzo	S&ID, Aerojet
Boilerplate 12 support	Las Cruces, New Mexico	April 24 to 29	Pumphrey	S&ID, WSMR
Tooling problems representation	Minneapolis, Minnesota; Cedar Rapids, Iowa	April 26 to May 1	Pringle	S&ID, Minneapolis-Honeywell; S&ID, Collins
Design verification test equipment survey	Burlington, Vermont	April 26 to May 2	Bratfisch	S&ID, Simmonds
Final development and design verification status review	Rocky Mount, Virginia	April 26 to May 2	Bratfisch	S&ID, Thompson Ramo Wooldridge
Service propulsion subsystem qualification tank test	Indianapolis, Indiana	April 26 to May 2	Furman	S&ID, Allison
Resolution of schedule problems	Cedar Rapids, Iowa	April 26 to May 8	Beeman	S&ID, Collins
Participation in computer programming demonstrations	Minneapolis, Minnesota	April 26 to May 9	Largent, Barnes	S&ID, Minneapolis-Honeywell
Drafting support	Las Cruces, New Mexico	April 26 to May 18	Hancock	S&ID, WSMR
Thermal vacuum subprogram, discussion	Bethpage, L.I., New York	April 27 to 28	Foust, Zuckerman	S&ID, Grumman
Technical development and test planning problems	Bethpage, L.I., New York	April 26 to 29	Sherman	S&ID, Grumman
Clarification of boilerplate 13 flight data	Cocoa Beach, Florida	April 27 to 29	Meyers	S&ID, KSC
Field analysis, negotiation of vendor quotations, and review of program status	Middletown, Ohio	April 27 to 30	Stover, Stockwell, Smith	S&ID, Aeronca

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S&ID Schedule of Apollo Meetings and Trips
April 16 to May 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Project engineering coordination	Sacramento, California	April 27 to May 1	Borde, Mower	S&ID, Aerojet
Coordination meeting	Melville, L.I., New York	April 27 to May 1	Rood, Flegal	S&ID, AIL
Communications and instrumentation sub-panel support	Houston, Texas	April 28	Chambers	S&ID, NASA
Communications and instrumentation sub-panel support	Huntsville, Alabama	April 29 to May 1	Chambers	S&ID, MSFC
Technical coordination meeting	Melville, L.I., New York	April 27 to May 1	Rood, Flugal, McCabe, Shaw, Commins, Corder, Coffee	S&ID, Airborne Instrument Lab
High-gain antenna vendors, design review	Beverly, Massachusetts; Stamford, Connecticut; Woodside, New York	April 27 to May 1	Marisoff, Ross, Wickert, Elston, Ilinski	S&ID, United Shoe Machinery, Barnes Engineering, Avien
Boilerplate 13 pyro sequencer compatibility test	Cocoa Beach, Florida	April 27 to May 4	Moore	S&ID, FF
Digital test command system, negotiation	Minneapolis, Minnesota	April 27 to May 8	Wallace	S&ID, Control Data
Apollo program management discussion	Sacramento, California	April 28 to 29	Bellamy, Edwards	S&ID, Aerojet
Service propulsion subsystem test review	Sacramento, California	April 28 to 29	Lewin	S&ID, Aerojet
Program management meeting	Lowell, Massachusetts	April 28 to 29	Lowery	S&ID, MIT
Optical devices, investigation	Chicago, Illinois	April 27 to May 1	Beam	S&ID, Chicago Aerial Industries
Optical devices, discussion	Dayton, Ohio	April 28 to May 1	Beam	S&ID, Wright Patterson AFB
Reaction control subsystem temperature control meeting	Bethpage, L.I., New York	April 28 to May 3	Simkin, Duncan, Chen, Piesik, Maize	S&ID, Grumman
Oxygen, humidity, and environment testing, briefing	Houston, Texas	April 29 to 30	Russo, Van Meter, Stoll, Benedict	S&ID, NASA
Pre-award supplier survey	Cupertino, California	April 29 to 30	Flanigan	S&ID, Edco

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S&ID Schedule of Apollo Meetings and Trips
April 16 to May 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Command subsystem panel meeting	Houston, Texas	April 29 to May 1	Covington	S&ID, NASA
High-gain antenna supplier coordination	Woodside, New York	April 27 to May 1	Matisoff, Holmberg	S&ID, Avien
Cleaning problems, review and analysis	Elyria, Ohio	April 29 to May 1	Butler, Errington	S&ID, Lear-Siegler
Data analysis review—Phase I, coordination for Phase II	Tullahoma, Tennessee	April 29 to May 1	Cadwell, Szalwinski	S&ID, Arnold Engineering
Engineering support design	Las Cruces, New Mexico	April 29 to May 1	Otzinger	S&ID, WSMR
Test data working group	Cocoa Beach, Florida	April 29 to May 1	Stratton	S&ID, KSC
Apollo test working group meeting	Cocoa Beach, Florida	April 28 to May 2	Rutkowski, Phillips, Wellens, Stratton	S&ID, KSC
Project engineering support	Cocoa Beach, Florida	April 29 to	Eslinger	S&ID, NASA
Propellant systems meeting	Huntsville, Alabama	April 29 to May 3	Waltzer	S&ID, NASA
Checkout equipment coordination	Cocoa Beach, Florida	April 29 to May 8	Larson, Mazur	S&ID, NASA
Conduct FSJ-1 tests	Hampton, Virginia	April 29 to May 15	Daileda	S&ID, Langley Research Center
Data analysis of Phase I review	Tullahoma, Tennessee	April 30 to	Field, Lewin	S&ID, AEDC
Minimum airworthiness requirements	Houston, Texas	April 30 to May 2	Kennedy	S&ID, NASA
Engineering field releases, coordination	WSMR, New Mexico	April 30 to May 4	Batson	S&ID, NASA
Boilerplate 12 glass specimens, examination	WSMR, New Mexico	May 1	Chinn	S&ID, NASA
Operating procedures	Cocoa Beach, Florida	May 1 to May 6	Remington	S&ID, KSC
Power amplifier discussion	Cedar Rapids, Iowa	May 1 to May 7	Hall	S&ID, Collins
Clear lake facility requirements coordination	Houston, Texas	May 3 to May 4	Henderson	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips
April 16 to May 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Witnessing of suit demonstration	Houston, Texas	May 3 to May 5	Dziedziula, Roebuck, Armstrong	S&ID, NASA
Part-task trainer support	Bethpage, L.I., New York	May 3 to May 5	Peacock	S&ID, Grumman
AMS model specification and design data manual requirements	Binghamton, New York	May 3 to May 5	Finley, Cobb	S&ID, Link
Zero-gravity flight test preparations	Dayton, Ohio	May 3 to May 6	Armstrong, Rosenberg	S&ID, Wright-Patterson AFB
Operating procedures	Cocoa Beach, Florida	May 3 to May 6	Highland	S&ID, NASA
Lunar landing facility review	Baltimore, Maryland	May 3 to May 6	Hufford	S&ID, Martin
Procurement of displays, systems information	Bethpage, L.I., New York	May 3 to May 6	Hufford	S&ID, Grumman
Arrangement of receiving inspection for boilerplate 15	Cocoa Beach, Florida	May 3 to May 8	Powers	S&ID, NASA
Project engineering coordination	Sacramento, California	May 3 to May 8	Borde, Mower, Carlson	S&ID, Aerojet
Docking simulation capability, review	Baltimore, Maryland	May 3 to May 8	Bohlen	S&ID, Martin
Countdown coordination meeting	Las Cruces, New Mexico	May 3 to May 9	Proctor	S&ID, NASA
Provide project integration representation	Houston, Texas	May 3 to May 17	Howard	S&ID, NASA
Thrust vector control systems, discussion	Houston, Texas	May 4 to May 5	Geheber	S&ID, NASA
Observation of training simulator	St. Louis, Missouri	May 3 to May 6	Rovelsky, Wheeldon, Wills,	S&ID, McDonnell
Flight table acceptance testing status, review	Shawnee, Oklahoma	May 3 to May 6	Rovelsky, Wheeldon, Wills	S&ID, Shawnee Industries
IMU temperature control resolution	Cocoa Beach, Florida	May 4 to May 6	Gresham, Hillberg	S&ID, NASA
Qualification testing, review	Houston, Texas	May 4 to May 5	Seibel, Kinsler, Stelzriede, Alexander, Flagel	S&ID, NASA
Apollo mission planning task force, discussion	Bethpage, L.I., New York	May 4 to May 6	Myers, Meston	S&ID, Grumman

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S&ID Schedule of Apollo Meetings and Trips April 16 to May 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Field operations planning	Huntsville, Alabama	May 4 to May 8	Fillbach	S&ID, NASA
AMS task group meeting	Houston, Texas	May 5 to May 6	Kitakis	S&ID, IBM
Film processing equipment procurement coordination	Las Cruces, New Mexico	May 5 to May 7	Landstrom	S&ID, NASA
PLSS interface meeting	Windsor Locks, Connecticut	May 5 to May 7	Roentgen, Quebedeaux Gould, Jobson	S&ID, Hamilton-Standard
Design verification ground rules, discussion	Minneapolis, Minnesota	May 5 to May 7	Kalayjian, Shimizu, Miller, Lum	S&ID, Minneapolis-Honeywell
Micrometeoroid capsule coordination	Huntsville, Alabama	May 4 to May 7	Krawicz, Keith, Tooley	S&ID, NASA
Configuration control solution	Las Cruces, New Mexico	May 5 to May 9	Biss, Peterson	S&ID, NASA
Flight qualification coordination meeting	Houston, Texas	May 5 to May 10	Sturkie	S&ID, NASA
Radar angle indicator meeting	Cambridge, Massachusetts	May 6 to May 7	Walker	S&ID, MIT
Selective freezing radiator program discussion	Houston, Texas	May 6 to May 7	Jay	S&ID, NASA
Checkout panel meeting	Houston, Texas	May 6 to May 7	Dunham, McMullin, Allen, Gebhart, Bunge, Siwolop	S&ID, NASA
Witnessing of development tests	San Carlos, California	May 6 to May 8	Lazarus	S&ID, Pelmec
GSE problems review	Las Cruces, New Mexico	May 6 to May 8	McGee	S&ID, NASA
Design review	Rolling Meadows, Illinois	May 6 to May 8	Simonsen	S&ID, Elgin
Boilerplate 12 prelaunch preparation	Las Cruces, New Mexico	May 6 to May 8	Pearce	S&ID, NASA
Program schedule review	Sacramento, California	May 6 to May 8	Field, Cadwell, Colston	S&ID, Aerojet
Boilerplate 12 flight review	WSMR, New Mexico	May 6 to May 9	Burke, Fugikawa	S&ID, NASA
Instrumentation functions, discussion	Cocoa Beach, Florida	May 6 to May 10	Zemenick	S&ID, NASA
Financial reporting requirements, review	Minneapolis, Minnesota	May 6 to May 13	Leffler	S&ID, Honeywell

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S&ID Schedule of Apollo Meetings and Trips
April 16 to May 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Design review	Rolling Meadows, Illinois; Tarrytown, New York; Chicago, Illinois	May 6 to May 14	Downes	S&ID, Elgin, Simmonds, IT&T
Boilerplate 12 operations support	WSMR, New Mexico	May 6 to May 15	Teter	S&ID, NASA
Boilerplate 12 flight review	WSMR, New Mexico	May 7 to May 9	Bazell	S&ID, NASA
Boilerplate 12 solid propulsion support	WSMR, New Mexico	May 7 to May 13	Babcock	S&ID, NASA
Boilerplate flight readiness review	WSMR, New Mexico	May 7 to May 15	Helms, Brooks, Babcock, Pearce, Young	S&ID, NASA
ATO support for boilerplate 12	WSMR, New Mexico	May 7 to May 9	Chiapuzio, Hereld	S&ID, NASA
Couch restraint system, review	Houston, Texas	May 7 to May 8	Madden, Opdyke, Underwood	S&ID, NASA
Toxic hazard program, review	Houston, Texas	May 7 to May 8	Clancy, Edgerley, Laubach	S&ID, NASA
GOSS document coordination	Houston, Texas	May 7 to May 8	Beatty, Koos	S&ID, NASA
Boilerplate 12 flight readiness review	WSMR, New Mexico	May 7 to May 8	Howard, Necker, Batson, Pyle, Otzinger, Lish	S&ID, NASA
Parachute drop test	El Centro, California	May 7 to June 3	Ames	S&ID, NASA, USN
Boilerplate 12 electrical pyrotechnic coordination	WSMR, New Mexico	May 8 to May 10	Neudorfer	S&ID, NASA
Monthly coordination meeting	Chicago, Illinois	May 8 to May 15	Villafan	S&ID, NASA
Simulation hardware discussion	Cambridge, Massachusetts	May 8 to May 15	Green, Jones, Robins, Savage, Silagyi	S&ID, MIT
LEM command and service module coordination	Bethpage, L.I., New York	May 8 to May 17	Albinger, Gomez	S&ID, Grumman
Flight readiness review boilerplate 12	WSMR, New Mexico	May 8 to May 19	Mann	S&ID, NASA
Part-task trainer, meeting	Bethpage, L.I., New York	May 10 to May 13	Abramson, Potts, Reid	S&ID, Grumman

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S&ID Schedule of Apollo Meetings and Trips
April 16 to May 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
G&N requirements	Binghamton, New York	May 10 to May 13	Fatton	S&ID, General Precision
Test results, evaluation	WSMR, New Mexico	May 10 to May 13	Schurr	S&ID, NASA
Add-on TV cameras, negotiation	Princeton, New Jersey	May 10 to May 13	Doll, Gigante, Leffler	S&ID, NASA
Signal conditioner design review	Boston, Massachusetts	May 10 to May 14	Walz	S&ID, Collins
Acceptance testing	Pompano Beach, Florida	May 10 to May 14	Hanchett	S&ID, Hoover
Schedule problems	Cedar Rapids, Iowa	May 10 to May 14	Hagelberg, Halverson	S&ID, Collins
Technical meeting	Binghamton, New York	May 10 to May 16	Flatto	S&ID, General Precision
Acceptance test procedure, correction	Minneapolis, Minnesota	May 11	Pimple	S&ID, Honeywell
Program discussion	WSMR, New Mexico	May 11	Benner, Kehlet	S&ID, NASA
Launch complex interface working group meeting	Cocoa Beach, Florida	May 11 to May 13	Crawford	S&ID, NASA
Flight mechanics review	Huntsville, Alabama	May 11 to May 13	Lucas	S&ID, NASA
GSE meeting	Cocoa Beach, Florida	May 11 to May 14	Bar	S&ID, NASA
SCS design engineering model and BME coordination	Minneapolis, Minnesota	May 11 to May 14	Jandrasi, Murphy	S&ID, Honeywell
Provide requirements for the 34, 37, and 39 launch complexes	Cocoa Beach, Florida	May 11 to May 15	Dorian, McArthur, Shelley	S&ID, NASA
Boilerplate 12 flight data reduction	WSMR, New Mexico	May 11 to May 15	Howard	S&ID, NASA
Launch operations of boilerplate 12	WSMR, New Mexico	May 11 to May 12	Myers	S&ID, NASA
Boilerplate 12 launch coordination	WSMR, New Mexico	May 11 to May 12	Harvey	S&ID, NASA
Boilerplate 12 pre-launch activities	WSMR, New Mexico	May 11 to May 13	Pearce	S&ID, NASA
Subcontractor review meeting	Sacramento, California	May 11 to May 14	Field, Goldstein	S&ID, Aerojet

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S&ID Schedule of Apollo Meetings and Trips
April 16 to May 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Technical progress coordination	Sacramento, California	May 11 to May 15	Borde, Carlson, Mower	S&ID, Aerojet
Design agreements negotiation	Cocoa Beach, Florida	May 11 to May 15	Beede	S&ID, NASA
Dimensional check	Middletown, Ohio	May 11 to May 15	Ball	S&ID, Aeronca
Monthly coordination meeting	Chicago, Illinois	May 11 to May 15	Downes, King, McAlister, Villafan	S&ID, ITT-Kellogg
Retrieve data from boilerplace 12	Houston, Texas	May 12	Dean	S&ID, NASA
Crew safety working panel meeting	Huntsville, Alabama	May 12 to May 13	Bertran, Geheber, Gordon	S&ID, NASA
Boilerplate 12 recovery team	WSMR, New Mexico	May 12 to May 14	Spencer	S&ID, NASA
Design review	Metuchen, New Jersey	May 12 to May 14	Bradanini, Saindon, Martin	S&ID, Applied Electronics
GSE coordination	Boulder, Colorado	May 12 to May 14	Kinsinger	S&ID, Beech
Investigate sub-contractor implementation	Springfield, Massachusetts	May 12 to May 14	Collins, Lowry	S&ID, Titeflex
Collins management discussion	Cedar Rapids, Iowa	May 12 to May 14	Hagelberg, Halverson, Pope	S&ID, Collins
Configuration management discussion	Houston, Texas	May 12 to May 15	Harrington	S&ID, NASA
Configuration management plan, review	Chicago, Illinois	May 12 to May 15	Campbell	S&ID, NASA
Facility interface coordination	WSMR, New Mexico	May 12 to May 15	Knoll	S&ID, NASA
Boilerplate 13 sequencer review	Cocoa Beach, Florida	May 12 to May 15	Necker	S&ID, NASA
Boilerplate 13 flight readiness review	Cocoa Beach, Florida	May 12 to May 16	Eslinger, Ross	S&ID, NASA
Fact finding negotiations	Boulder, Colorado	May 12 to May 16	Bouman	S&ID, Beech
Ignition characteristics	Dayton, Ohio	May 12 to May 17	Stephanou	S&ID, Monsanto Research
Boilerplate 13 flight readiness review	Cocoa Beach, Florida	May 12 to May 27	Eslinger, Litsikas	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips April 16 to May 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Witnessing of tests	Goleta, California	May 13	Jones, Richardson	S&ID, General Motors
Mission planning task force	Houston, Texas	May 13 to May 14	Meston, Milliken	S&ID, NASA
F-1 committee combustion stability review	Sacramento, California	May 13 to May 14	Cadwell	S&ID, Aerojet
Subsystem panel task assignment	Scottsdale, Arizona	May 13 to May 14	Covington	S&ID, Motorola
SPS engine subsystem review	Sacramento, California	May 13 to May 14	Beltran	S&ID, Aerojet
Specifications and schedules, discussion	Minneapolis, Minnesota	May 13 to May 15	Hunt, Lindner	S&ID, Rosemount Engineering
Contingency analysis	Bethpage, L.I., New York	May 13 to May 17	Jones, Levine, Vucelic	S&ID, Grumman
SCS support discussion	Binghamton, New York	May 13 to May 17	Flatto, Kalayjian	S&ID, Grumman
Electrical power interface discussion	Cambridge, Massachusetts	May 13 to May 17	Quebedeaux	S&ID, MIT
Redesign coordination	Elkton, Maryland	May 13 to May 17	Yee	S&ID, Thiokol
GOSS flyover equipment, discussion	Greenbelt, Maryland	May 13 to	D'Ausilio, Beatty	S&ID, NASA
Earth impact system, review	Houston, Texas	May 14 to May 15	Underwood	S&ID, NASA
Airframe 008 R&D instrumentation, discussion	Houston, Texas	May 14 to May 15	Feltz, Foust, Underwood	S&ID, NASA
Boilerplate 13 flight readiness review	Cocoa Beach, Florida	May 14 to May 16	Otzinger	S&ID, NASA
Review of proposed facilities	Minneapolis, Minnesota	May 14 to May 16	Dieterle	S&ID, Honeywell
Alpha particles, discussion	Berkeley, California	May 15	Raymes	S&ID, University of California

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